The proof of the pudding is in the eating ...or is it in the cooking?

A personal tale

Generalizations have been made before about the relationship between 'researching by design' and 'designing'. In this article I will give a personal view of some similarities between my research and my design process. The following is an extension of the attended workshop 'Positioning in Knowledge Landscape' with Fredrik Nilsson and Halina Dunin-Woyseth, held in September 2009.

My work as a structural engineer (at my school of architecture and in my engineering office) has a more creative part (e.g. designing a structural concept) and a more scientific, computational part (e.g. dimensioning a structural element according to the building codes). My interest of research lays in this creative, non-computational part, especially in designing the structural concept in accordance with the architectural concept. This involves incorporating architectural design objectives in the structural design process, and vice versa incorporating structural objectives in the architectural design process.
I consider my research a 'research by design' because both the use of my design experience and of my design abilities as structural engineer (i.e. the creative part) are required for my research activities. Furthermore I use my design practice for research experiments which gives me the possibility to record my inner thought as engineer.

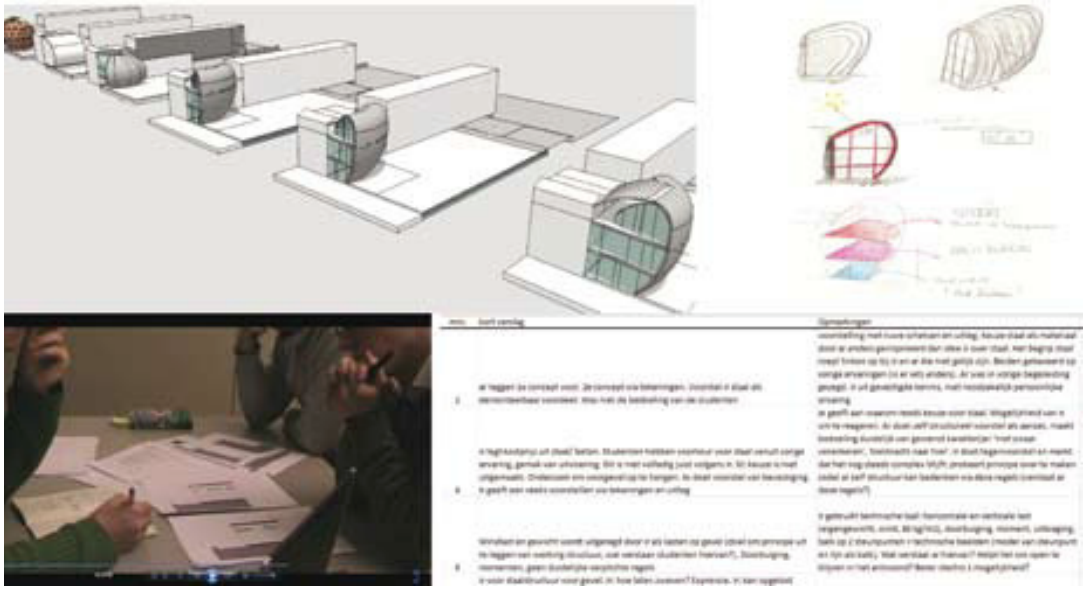

Fig.1: example of the use of my practice with students for research experimentation.

Similarities between designing and researching

A wicked problem

When analysing my own research activities and my design activities as structural engineer, I can find several similarities. In both cases it starts with a specific practical[1] problem, with no definitive formulation, and with a solution that is neither true or false, but rather good or bad. It is a wicked problem as Rittel and Webber have described it (Rittel & Webber 1973), where the problem only becomes defined when a solution is found.

In my work as engineer, the problem presents itself as a question to design a structure for a given architectural design proposition. Although this problem is specific, all the involved design criteria are not known at the beginning of the design process (e.g. if an extra column can be incorporated in the architectural design, if it would be needed) and thus the problem formulation evolves during the process. There are many structural solutions possible, which might be ordered from worse to better, but not as true or false.

My research goal is to improve the integration of structural design and architectural design in a professional field where engineers often have to design a structure to fit in an already detailed architectural design. Although my goal is clear, defining the actual problem is not. As with designing a structure, many starting points are available for developing a valuable solution (e.g. focusing on the engineering abilities of the architect or on the design process instead of the actors). Only by pursuing a certain research path and evaluating the findings, the problem becomes more clear. And of course any found solution will never be absolutely true or false, but rather good or bad.

A cyclic process: proposition – evaluation – problem adaptation – new proposition

Designing and researching are both a cyclic process. It starts with a proposition to the presented problem, then an evaluation of this proposition which leads to a better understanding of the presented problem and an adaptation of the problem formulation. This brings the cycle back at the beginning by developing a new proposition for the adapted problem formulation.

When developing the first proposition, the presented problem is often still very unclear. So my first throw at finding a solution is based upon my personal 'experience of doing' (i.e. experiential knowledge) and upon my discipline-related theoretical knowledge.

1 'Practical' in opposition to 'hypothetical'.

Experiential knowledge
The experiential knowledge I use as engineer, is developed through all my previous projects where I designed structures before: I know which kind of structural solutions were good for certain projects on the level of conceiving the concept, collaborating with architect and contractor, and putting the structure together.

The experiential knowledge I use as researcher is based upon my previous collaborations with architects as engineer, upon my work as engineer designing structures, and in a smaller extend upon my work as architect designing architecture. Most of my experience in scholarly research lays in the field of natural sciences and not of design.

Theoretical knowledge
The theoretical knowledge which helps me to design structures as a paradigm to operate in, is part of the structural engineering sciences. It enables me to calculate structures, which in turn tells me how they work, and finally leads to understand the logic of structures, which is essential in designing structures. It also represents a catalogue of structural typologies to choose from during design.

For my research, the acquired theoretical knowledge lays mainly in the field of architecture and engineering sciences. My knowledge on creative collaboration, (multidisciplinary) design, communication, research by design and other areas of interest to my research-project, needed to be further developed.

Proposition
The structural design proposition is mainly the structural concept, which represents the way the structure brings all the imposed loads to its foundations. It consists of the structural elements (e.g. beams, slabs and columns) and their connections.

The research proposition is mainly a concept for improvement. In the beginning I was focused on helping the architect to deal with the structural knowledge needed to pre-design a structure. My aim was to develop a software-tool made for architects, to pre-dimension structural elements, and to reorganize the current structural knowledge to enhance the structural insight of the architect.

Evaluation
In structural design the proposition is mainly evaluated by dimensioning some crucial structural elements to check if they meet a self-chosen structural goal, by comparing the structural volume with the architectural building volume, and by presenting the proposition to the architect for approval.

In the beginning of my research process the evaluation is done through hypothetical testing: imagining what such a software-tool could be and how it could be used in my

ongoing design projects. This software-concept is also presented to architects to get their opinion.
As the research progresses the testing becomes more real: by actually developing the software-tool unforeseen problems become apparent. And in a future stage a final software-tool could be tested by architects for evaluation.

Adaptation of the problem formulation
When a structural element fails to meet a structural goal (i.e. often an optimisation requirement), the choice is made to except this shortcoming or to redesign the structure and try to acquire this goal. In case the structural volume does not fit into the presented architectural volume, the structure is presented as such to the architect for negotiation, or redesigned in order to fit. When the structural design is presented to the architect for evaluation, new architectural requirements may appear which change the problem formulation.

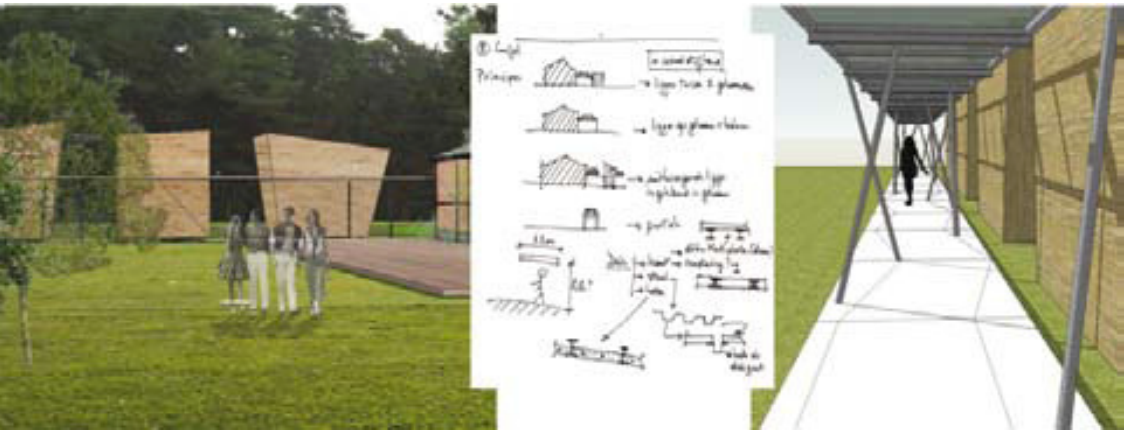

Fig.2: example of design negotiation which lead to a problem reformulation (i.e. from a requirement of 'no columns' to a 'wood of columns') © TEEMA-architecten.

In my research the problem formulation shifted through the development of my theoretical background and through the evaluation of my developed concepts for improvement. It made me understand that an easy to use software tool to pre-dimension the structure, won't include the engineer's experience on designing and building (e.g. an engineer knows which structural designs are difficult to build in a certain context), and therefore might deliver non-practical data. Furthermore software basically solves problems where the solutions falls within a preconceived solution space, and thus very likely produce routine design solutions, where my aim lays in producing creative design solutions.
Even more, much already exists on helping the architect pre-design structures (e.g. rules of thumb to pre-dimension, inspirational catalogues of structural typologies (e.g. Engel & Rapson 1967)) and still the integration of the structural and the architectural design remains an issue. This made me conclude that the answer may not lay in making the architect a better engineer, but that more is to be found in the collaboration of architect and engineer. Where both actors are expert in their field and able to be creative designers, but mainly need to get their separate design process in tune with one another. This change of problem formulation is a consequence of my endeavour in finding a software tool to help the architect and of my scholarly reading, which both delivered new elements of the problem.

New proposition
A new structural proposition can range from a new designed structural concept to a further refinement of an already approved concept. Compared to my research process, the amount of cycles in the design process is often limited due to my experience in structural designing and in collaborating with the same architects.

My new research propositions can also range from small adjustments to big changes of the previous proposition. Small adjustments on the software-tool are made first, trying for example to incorporate the building reality of structural systems, to the point that so many adjustments are needed that the software loses its ease of use for architects. Eventually the problem formulation is shifted towards the collaboration of architect and engineer and leads to a major change of the research proposition: from a structural design tool for architects to a communication language for design negotiation between architect and engineer in the early phase of the design process.

Different ways of making pudding

In both cases of design and research, producing a proposition is the first step of the cycle and the most creative part of the process. (The evaluation of the proposition is often a more apparent step to take). A key element in creating a proposition is getting inspired. In design, inspiration is sometimes found in looking at design examples, but also in many other things not directly related to the design subject like watching a movie, reading a book or seeing a flower. Inspiration comes often unexpected through a medium that was not always intended for that use. The designer generally does not need to understand the intended meaning of the medium or how it inspired him. His main concern is to deliver a valuable design by any necessary means of inspiration. (However understanding the intended meaning can sometimes become useful for further inspiration).
The designer is (practical) solution driven: he aims at producing a single design (for a specific problem) that meets certain standards. The path to get there is of less importance. The proof of his pudding is eventually in the eating: the value of the design is proven in the final use and appreciation of the end product. In my case this means that when the building still stands (without cracks) after several decades and the

structure has contributed to the architectural quality of the building, the structural design has proven to be good. The process I followed to come to this end design has very little impact on this proof of quality.

When the designer is doing research and operates in the world of scholars, his working process comes into focus. In this world, propositions are developed from established theories. The developed terminology in these theories are only to be used according to their intended meaning (and not according to the designer's personal interpretation). Here the used methods of operating (i.e. researching) are to be made explicit and applied according to scientific rules. The researcher is theory development driven: he aims at producing a theory applicable to different cases, where the value of this theory is mainly proven by the way he researches. For the researcher the proof of the pudding is in the cooking. Through rigorously applying the existing scientific theories and methods the researcher builds a case to prove the value of his findings. The designer doing research tends to be less rigorous in applying these theories and methods, because he is mainly used to look for inspiration and not for proof during the process: the designer finds proof in the end result alone. (His working process is mainly a personal matter not intended to be made public). In my opinion the modus operandi of the designer and the researcher can lead to two different ways of making pudding: a more experimental way of trial and error, where the cook creates a pudding he likes before presenting it to others for approval, and a more thought-through-approach in consultation with other renowned chefs, creating a good pudding recipe before actually making the pudding.

During my research I have used both ways of making pudding: testing in practice personal ideas of improvement with little theoretical knowledge on the matter, and gradually getting acquainted with theories and methods of research on multi-disciplinary design. The first gives me a quick practical way into the problem I'm dealing with, the latter broadens up the problem formulation to me which enables a wider range of proposition creation.

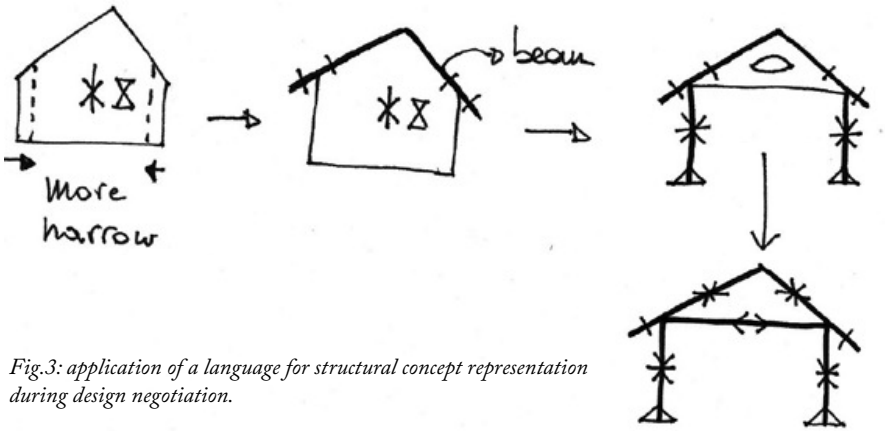

Fig.3: application of a language for structural concept representation during design negotiation.

How do I expect to proof the value of the pudding I'm making? The language I'm developing now for negotiation between architect and engineer, needs to work in my practice first. Here the proof must be in the eating (i.e. actually me eating this pudding). Then this language can be presented to other practitioners (i.e. peers) for their opinion. And if my findings are practically applicable, it could even be scientifically tested in practice and evaluated.
In case the findings are less testable, more emphasis will lay on the way the findings are produced to proof their value: this will lead to post-rationalisation of the research project. Here the proof is in the cooking: building a sound case from established theories and methods with a clear route mapping of the research process to argue for the research findings.

Conclusion

As designer and researcher I both have to deal with wicked problems, where the problem formulation is not definitive and the problem only gets known when the solution is found. To come to an end result a cyclic process is followed of making a proposition for the current problem formulation, evaluating this proposition which in turn leads to reformulating the problem. The cycle then comes back to the starting point by looking for a new proposition for this reformulated problem. In my design process there are less cycles to follow than in my research process due to the difference in complexity of the problems and in my experience of designing and researching.
As designer I'm used to be focused on the end result and little on the design process itself. As researcher I need to develop more rigour in the working process by looking at established theories and methods and by presenting a clear route mapping of my research. It is a different way of making pudding than I'm used to, but both the designer and the researcher in me have the same goal: making an excellent pudding!

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References

Engel, H. & Rapson, R., 1967. *Tragsysteme/Structure Systems*, Stuttgart: Deutsche Verlags-Anstalt.

Rittel, H. & Webber, M., 1973. Dilemmas in a general theory of planning. *Policy Sciences*, 4(2), 155-169.